

S'COOL BREEZE



Engaging students in authentic science to advance our knowledge of Earth through
Students' Cloud Observations On-Line

Volume 3, Issue 12

Explore. Discover. Understand.

June 2005

Scientists Confirm Earth's Energy Is Out of Balance



by Rani Chohan - Goddard Space Flight Center

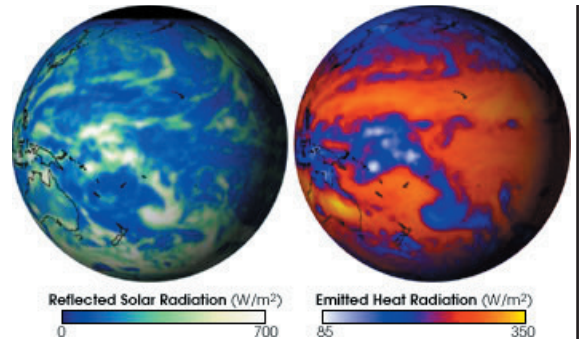
Scientists have concluded more energy is being absorbed from the sun than is emitted back to space, throwing the Earth's energy "out of balance" and warming the globe.

Scientists from NASA, Columbia University, New York, and Lawrence Berkeley National Laboratory, Berkeley, Calif. used satellites, data from buoys and computer models to study the Earth's oceans. They confirmed the energy imbalance by using precise measurements of increasing ocean heat content over the past 10 years.

The study reveals Earth's energy imbalance is large by standards of the planet's history. The imbalance is 0.85 watts per meter squared. That will cause an additional warming of 0.6 degrees Celsius (1 degree Fahrenheit) by the end of this century.

To understand the difference, think of a one-watt light bulb shining over an area of one square meter (10.76 square feet). Although it doesn't seem like much, adding up the number of feet around the world creates a big effect. To put this number into perspective, an imbalance of one-watt per square meter, maintained for the past 10,000 years is enough to melt ice equivalent to one kilometer (.6 mile) of sea level, if there were that much ice.

"The energy imbalance is an expected consequence of increasing atmospheric pollution, especially carbon dioxide, methane, ozone, and



Clouds and the Earth's Radiant Energy System (CERES) measurements show the reflected solar radiation (left) and emitted heat radiation (right) for January 1, 2002. In both images, the lightest areas represent thick clouds, which both reflect radiation from the Sun and block heat rising from the Earth's surface. Notice the clouds above the western Pacific Ocean, where there is strong uprising of air, and the relative lack of clouds north and south of the equator. The animation, created from daily data, shows how rapidly these measurements change.

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NASA's 'Great Earth Observatory' Marks Five Years of Climate Discoveries

by Lynn Chandler
Goddard Space Flight Center

Five years ago this month, NASA's Terra satellite began measuring Earth's vital signs with accuracy, precision, and resolution the world had never seen before. This great Earth observing satellite was launched to look at many aspects of Earth's changing climate. Terra has been very successful in its mission to advance our understanding of Earth's climate system to help improve our quality of life.

Launched on December 18, 1999, Terra's five onboard instruments began science operations in February 2000. Terra's goal is to assess the health of the planet by providing comprehensive information about Earth's land, oceans and atmosphere. Terra orbits the Earth more than fourteen times a day and observes nearly the entire globe.

"Terra is Earth science's first great observatory," said Bruce Wielicki, Senior Scientist for Earth Science at NASA's Langley Research Center, Hampton, Va. who uses Terra data to monitor how much of the Sun's energy is being absorbed and reflected by Earth. "Terra has provided the most comprehensive and the most accurate global view of the Earth's climate on record. And it has pioneered the first comprehensive, multi-instrument approach to climate change research."

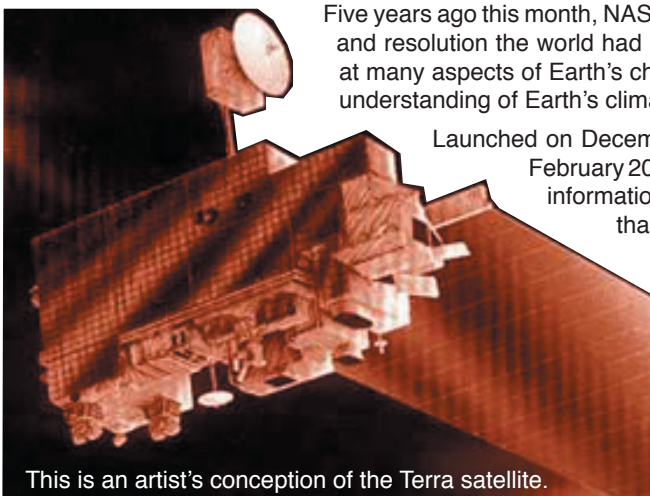
Sending home roughly 1 million megabytes of data per day, Terra is

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S'COOL
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STUDENTS' CLOUD OBSERVATIONS ON-LINE

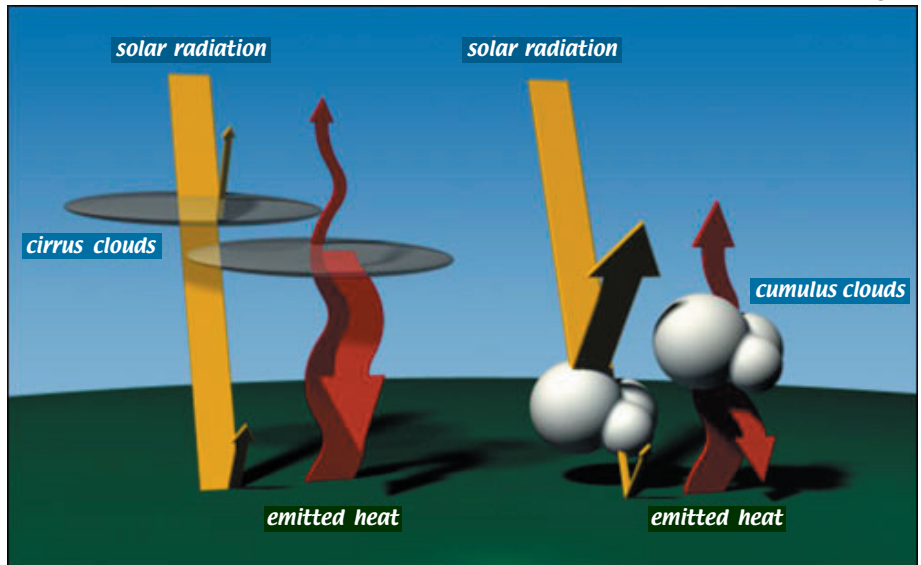


This is an artist's conception of the Terra satellite.

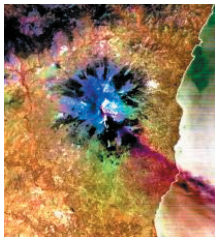
black carbon particles. These pollutants block the Earth's heat radiation from escaping to space, and they increase absorption of sunlight," said Jim Hansen of NASA's Goddard Institute for Space Studies, New York. He is the lead author of the new study, which is in this week's Science Magazine Science Express.

As the Earth warms it emits more heat. Eventually the Earth will be back in balance, if the greenhouse gas emissions are kept at the same level of today. Scientists know it takes the ocean longer to warm than the land. The lag in the ocean's response has practical consequences. It means there is an additional global warming of about one degree Fahrenheit that is already in the pipeline. Even if there were no further increase of human-made gases in the air, climate would continue to warm that much over the next century.

Warmer world-wide water temperatures also affect other things. "Warmer waters increase the likelihood of accelerated ice sheet disintegration and sea level rise during this century," Hansen said. Since 1993, sea levels have been measured by satellite altimeters. Data has shown they have risen by approximately 3.1 centimeters or 1.26 inches per decade. Although 3.1 centimeters is a small change, the rate of increase is twice as large as in the preceding century. There are positive feedbacks that come into play, as the area of ice melt increases. The researchers agree monitoring ice sheets and sea level is necessary to best ensure the system is in balance. For animations for this article visit: http://www.nasa.gov/centers/langley/science/earth_energy.html



The Earth's energy budget considers the amount of energy coming from the sun (yellow arrows) minus the energy reflected (yellow) and emitted (red arrows) by the Earth. Clouds play an important role in controlling this budget. Thin cirrus clouds allow the passage of sunlight, and block the heat emitted from the surface. Thick cumulus clouds reflect part of the sunlight, and retransmit most of the heat coming from the surface.



Quarter's Worth of Websites

Jet Propulsion Laboratory: Terra's World Tour

<http://www.jpl.nasa.gov/multimedia/terra5/?msource=032505&tr=y&auid=787094>

For the past five years, NASA's Terra satellite has documented Earth's changing landmasses, surface temperature, oceans, clouds and atmosphere. Enjoy this interactive program that highlights images taken by instruments found on the Terra satellite along with details describing all of the images.

Where on Earth? Become a Geographical Detective:

<http://www-misr.jpl.nasa.gov/education/whereonearth.html#introduction>

Embark upon a geographical adventure with MISR's Mystery Image Quizzes. These puzzles are designed to inspire understanding of the physical, biological and human processes that influence our home planet and cover topics from Archaeology to Zoology. Several resources for discovering and revealing the meaning of image features may help new geographical detectives to solve the challenging quiz questions.



Teacher Corner

Over 1865 participants are now registered.
Keep spreading the word!

Have you changed your school information?
Please remember to notify us of any changes in your school information or e-mail address.

Are you ready for the countdown?

This Year's Top 25 S'COOL Observing Schools will be posted on-line during the month of June. Thanks to all of you, we now have over 41,000 observations in our database. Close to 25% have corresponding satellite data. Stay tuned for upcoming activities on how to use these data with your students.



Thank you for your continued participation!

Another CERES PLAYER



David F. Young

Acting Deputy Director
Science Directorate

Responsible for leading research in Earth and Space Science at Langley Research Center
Born 1955 in Philadelphia, Pennsylvania, USA

Spotlight on Atmospheric Careers

Education:
B.S. Astrophysics at Michigan State University
M.S. Meteorology at Pennsylvania State University

Favorite School subject(s):
Celestial Mechanics, Physical Climatology, and Comparative Literature

Favorite Hobbies:
Volleyball, Music collecting and video games

What do I like most about my job:
Working on research related to climate that has a major benefit for the public.

What advice do I have for someone interested in an Atmospheric Science Career:
Don't limit your studies to a particular field. Scientists need a broad background in not only math and science, but also computer skills, writing, public speaking, and ethics. Never stop learning and never stop questioning what you learn. That is the essence of science.

(continued from page 1 - NASA's... Earth Observatory...)

helping scientists all over the world tackle important questions about the causes and effects of environmental changes. While the mission is still in the process of fulfilling its main science objectives, Terra's portfolio of achievements to date already makes the mission a resounding success.

Terra monitors movements of carbon through Earth's climate system. Humans annually release more than 7 billion tons of carbon into the atmosphere through the burning of fossil fuels. Yet, scientists cannot account for where all this carbon ends up. Between 1 and 2 billion metric tons of carbon per year are "missing" from the global carbon budget. Terra is providing scientists with some important clues to help them solve the mystery of the missing carbon.

Terra data have also helped improve weather prediction. Terra's ability to track the speed, direction, and height of clouds allows scientists to accurately measure how strong and which way the wind is blowing over areas where they had little data before, such as over oceans.

Two years ago meteorologists at the European Centre for Medium-Range Weather Forecasts (ECMWF) began using Terra MODIS data to track clouds over the Arctic Circle. The result is a 3-hour advance in the accuracy of forecasts in that region.

Terra provides scientists with much more accurate information on Earth's albedo (or reflected sunlight) over areas where before they could only make educated guesses.



Terra Logo



Terra sits on the launch pad aboard the Atlas II vehicle.

The end result is improved weather forecasts in Northern Africa, the Arabian Peninsula, and across great expanses of the mostly uninhabited northern boreal forests of North America and Asia.

The mission's unique combination of sensors allows scientists worldwide to monitor fires, floods, severe storms, and volcanic activity in near real time. Today organizations all over the world are using data from four different instruments aboard Terra as part of their ongoing efforts to monitor the causes and effects of natural hazards.

The U.S. Environmental Protection Agency (EPA) uses Terra data to help monitor air quality. EPA scientists found that Terra's combined precision and big picture perspective far exceed their ability to measure aerosol and carbon monoxide pollution from individual locations all across the United States.

Terra also watches cloud and tiny pollutant particle (aerosol) concentrations in the air; snow and ice cover on the surface, and gives scientists an eye on areas of expanding deserts and cities, and deforestation.

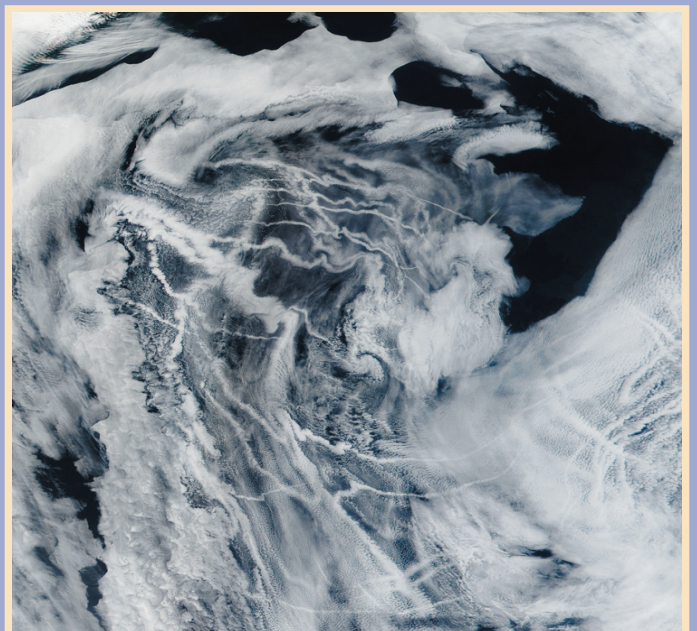
Terra's view of Earth from space is one that is critical in understanding all of the changes occurring in Earth's land, oceans, atmosphere and overall climate.

For more information about Terra visit:
<http://terra.nasa.gov>

NASA STEMS

NASA Science Trivia to Excite & Motivate Students

We know that you have seen plenty of satellite imagery pertaining to contrails in former Breeze issues. In fact, for the June 2004 issue we introduced you to Terra satellite imagery depicting a contrail outbreak over the SE United States. But how about these 'trails,' or should we say 'tracks?' These "ships' tracks" in the sky over the northern Pacific are an example of how human pollution can form or modify clouds. Sulfur dioxide particles released in ships' smokestacks rise up into the atmosphere and make cloud droplets smaller, giving clouds a brighter, whiter, "streaked" appearance. This image was taken by the MODIS (MODerate-resolution Imaging Spectroradiometer) instrument on board the Terra satellite. For more imagery check out the JPL: Terra's World Tour found in this issue's Quarter's Worth of Websites.



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UPCOMING EVENTS

AGU Joint Assembly Meeting/GIFT Teacher Workshop
March 23-27, 2005
New Orleans, LA, USA

Rensselaer Polytechnic Institute
June 9-12, 2005
Troy, NY, USA

DLESE Annual Meeting
July 9-13, 2005
St. Petersburg, FL, USA

EPO Conference
September 14-16, 2005
Tucson, AZ, USA

<http://asd-www.larc.nasa.gov/SCOOOL/visits.html>

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Roberto Sepulveda, Spanish translator

An encouragement for all students!

"I should give thanks for everything you have done to encourage us and to tell you that I am proud to be a part of S'COOL. Today, in our school bulletin, they talked about the our collaboration with NASA...we have even come out two times in the school's newspaper. Today students from fourth and fifth grade arrived at the weather station to learn about clouds and S'COOL. They loved it!!! Thanks to God, everything is going well and almost all elementary classes have come to learn about clouds and S'COOL. The teachers from the elementary grades also like S'COOL."

Francesca Pollarolo Aranda, student, American Nicaraguan School, Managua, Nicaragua